Service Outsourcing, Productivity and Employment: Evidence from the US*

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This draft -August 2005. Preliminary. Comments welcome.

Abstract

This paper estimates the effects of international outsourcing of services and material inputs on productivity and manufacturing employment in the US between 1992 and 2000. The results show that service outsourcing is positively associated with productivity, and it has a small negative effect on employment, using disaggregated manufacturing industry data (450 industries). However, at a more aggregated level (96 industries) this effect disappears, which implies that substitution effects away from labor are offset by increased demand in other industries.

Keywords: outsourcing, services, employment, productivity

JEL Classification: F1 F2

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1. Introduction

The increasing practice of international outsourcing of service inputs has led to a heated debate on whether the US should stop the "exporting of jobs", with a strong push for protectionist legislation. For example, on March 4, 2004 the US Senate passed restrictions on international outsourcing by barring companies from most federal contracts if they planned to carry out any of the work abroad.[1] In this paper we address whether these fears of job losses due to outsourcing are well founded. We estimate whether outsourcing does lead to job losses, and whether there are any offsetting benefits in the form of productivity growth.[2]

When the media and politicians talk of outsourcing they are usually referring to international (rather than domestic) outsourcing, that is, tasks that can be performed in the US are instead performed abroad. Recent examples include call centers in India, and some more skill intensive tasks such as computer software development. The main difference between outsourcing and international trade more generally is that outsourcing involves the slicing up of the production chain. So rather than relocating the whole production of a good to another country the US keeps performing those parts that it has comparative advantage and relocates the others abroad, and engages in international trade by importing inputs and/or services and exporting final goods. This phenomenon is not in itself new. Outsourcing of material inputs dates back many decades.[3] What is relatively more novel is that this kind of trade is now also in services - areas which in the past were seen as non-tradable. The advancement of new technologies has made trade in service increasingly possible. But it should be noted that even though service outsourcing is growing annually at 6.3 percent, it is still at very low levels increasing from 0.2 percent to 0.3 percent between 1992 and 2000 compared with material outsourcing which is as high as 17.4 percent. See Table 1.

In this study, we use annual input/output tables, combined with trade date, to measure service and material outsourcing, which we define as the share of imported services and materials, respectively, analogous to the measure of material outsourcing in Feenstra and

[1] Some exceptions were to apply, for example defence, homeland security and intelligence contracts deemed necessary for national security, but this legislation was not passed in the House.

[2] Note that we do not undertake an overall welfare analysis, and recognize that there could be negative effects such as a deterioration in the terms of trade.

[3] The fragmentation of production stages has been widely studied within a trade theoretic framework by Dixit and Grossman (1982), Jones and Kierzkowski (1990, 1999, 2001), Deardorff (1998a, 1998b), Cordella and Grilo (1998), Amiti (2005) and others. This same phenomenon has also been referred in the literature as international production sharing, globalized production, de-localization, slicing up the value chain and offshoring. Some authors go on to distinguish between who owns the production stage abroad: when it is owned by the same firm it is referrred to as vertical FDI or intra-firm trade; and when it is owned by a foreign firm is it referred to as arms length trade. Antras and Helpman (2003) distinguish between domestic and foreign outsourcing.

Hanson (1999).[4] We estimate the effects of international outsourcing on productivity and employment, using US industry level data between 1992 and 2000 for all manufacturing industries.

Outsourcing can increase productivity either due to compositional or structural changes. If a firm relocates its relatively inefficient parts of the production process to another country, where it can be produced more cheaply, it can expand its output in stages it has comparative advantage and increase average productivity. Furthermore, outsourcing might make it possible to engage in structural changes that push out the production possibility frontier or there could be knowledge spillovers from importing service and material inputs. These productivity benefits can translate into job losses since the same amount of output can be produced with fewer inputs. Also, lower prices of imported inputs could lead to substitution away from domestic labor demand. Alternatively, outsourcing could result in higher demand for labor due to scale effects. Higher productivity can lead to lower prices generating further demand for output and labor. As firms become more competitive, demand for their goods could rise and hence increase derived demand for labor, so the net effect in theory is ambiguous. Hence, rigorous empirical analysis is necessary to determine the net effect on employment. We use a standard labor demand framework to estimate the effects of outsourcing on employment.

The results show that service outsourcing has a significant positive effect on productivity in the manufacturing sector. Using this same level of aggregation of 96 industries we find that there is a negative correlation between outsourcing and employment when holding output constant. However, allowing for scale effects we found this effect disappeared. The increase in output and demand for labor in other industries within the same sector classification offsets any negative employment effect. However, at a more disaggregated division of the manufacturing sector of 450 industries we were able to detect a negative significant effect, although this was not robust across all specifications. Service outsourcing reduced manufacturing employment by around 0.4 of a percent. Interestingly, one does not need to aggregate sectors very much to find this effect washes out.

The focus in the media and politics has been on outsourcing and job losses. The newspapers are full of estimates on the effects of outsourcing on jobs, which primarily come from management consultants. For example, management consultants at McKinsey forecast offshoring to grow at the rate of 30 to 40 percent a year over the next 5 years. They report that a leading IT analyst, Forrester, projects that the number of U.S. jobs that will be offshored will grow from 400,000 jobs to 3.3 million jobs by 2015, accounting for $136 billion in wages.

[4] Strictly speaking, the term international outsourcing should only apply to imports from unaffiliated plants. However, we are unable to distinguish between imports from affiliate and unaffiliated plants, so our measure includes arm's length and intra-firm trade, which is sometimes referred to as offshoring.

Of this total, 8% of current IT jobs will go offshore over the next 12 years. The report goes on to say that fears of job losses are being overplayed, but it is unclear how their numbers are derived. The only rigorous study of job market effects in the US is by Feenstra and Hanson (1996, 1999) but their focus is on material outsourcing and its effects on the skill wage premium. They do not consider the effects of service outsourcing, nor do they consider the effects on employment. Feenstra and Hanson (1996) found that the change in outsourcing intensity in the 1970s was statistically insignificant; whereas in the 1980s it explained over 50 percent of the increase in non-production wages.

There are very few studies on the effects of service outsourcing on productivity. There is only one study on productivity and international outsourcing of services in the US (see Mann, 2004)[5] and a few others on Europe. The US study by Mann (2004) is a "back of the envelope" type calculation and only considers the IT industry. She calculates that outsourcing in the IT industry led to an annual increase in productivity of 0.3 percentage points for the period 1995 to 2002, which translates into a cumulative effect of $230 billion in additional GDP.[6] There have been a few more studies on the productivity effects of outsourcing using European data. Gorg *et al* (2005) find that international outsourcing of intermediate material inputs had a positive impact on productivity yet service outsourcing had no effect in Ireland between 1990 and 1998 using plant level data. Girma and Gorg (2003) find positive evidence of service outsourcing on labor productivity and total factor productivity in the UK between 1980 and 1992, but they are unable to distinguish between domestic and foreign outsourcing, and the study only covers three manufacturing industries.[7] In contrast, we focus on international outsourcing and our data covers all manufacturing industries in the US.

The rest of the paper is organized as follows. Section 2 sets out the model and estimation strategy. Section 3 describes the data. Section 4 presents the results and Section 5 concludes.

[5] Ten Raa and Wolff (2001) find evidence of positive effects of domestic outsourcing on US manufacturing productivity – it explains 20% of productivity growth.

[6] This is calculated as follows: globalization led to a fall of 10 to 30 percent in prices of IT hardware; taking the mid-point of 20% times the price elasticity of investment equals the change in IT's investment to productivity growth. See footnote 5 in Mann (2004).

[7] Egger and Egger (2001) study the effects of international outsourcing of materials inputs. They find that material input outsourcing has a negative effect on productivity of low skilled workers in the short-run but a positive effect in the long-run. They found that international outsourcing contributed to 3.3% of real value added per low-skilled worker in the EU from 1993 to 1997. They attribute the negative short-run effect to imperfections in the EU labor and goods markets.

2. Model and Estimating Framework

2.1. Model

The production function for an industry i is given by

$$Y_i = A_i(oss_i, osm_i)F(L_i, K_i, M_i, S_i), \tag{2.1}$$

where output, Y_i, is a function of labor, L_i, capital, K_i, materials, M_i, and service inputs, S_i. The technology shifter, A_i, is a function of outsourcing of services (oss_i), and outsourcing of material inputs (osm_i).

There are at least four possible channels through which outsourcing can affect productivity, A_i: (i) a static efficiency gain; (ii) restructuring; (iii) learning externalities; and (iv) variety effects. First, when firms decide to outsource materials or services they relocate the less efficient parts of their production stage, so average productivity increases due to a compositional effect. Second, the remaining workers may become more efficient if outsourcing makes it possible for firms to restructure in a way that pushes out the technology frontier. This is more likely to arise from outsourcing of service inputs, such as computing and information, rather than outsourcing of material inputs. Third, efficiency gains might arise as firms learn to improve the way activities are performed by importing services. For example, a new software package can improve the average productivity of workers.[8] Fourth, productivity could increase due to the use of new material or service input varieties as in Ethier (1982). Since we cannot distinguish the exact channel of the productivity gain arising from outsourcing, we will specify it in this more general way as entering A_i.

We assume that a firm chooses the total amount of each input in the first stage, and chooses what proportion of material and service inputs will be imported in the second stage. The fixed cost of importing material inputs, F_k^M, and the fixed cost of importing service inputs, F_k^S, vary by industry k. This assumption reflects that the type of services or materials required are different for each industry, and hence importing will involve different amounts of search costs depending on the level of the sophistication of the inputs.

Cost minimization leads to the optimal demand for inputs, for a given level of output, Y_i. The conditional labor demand is given by

$$L_i = g(w_i, r_i, q^m, q^s, Y_i)/A_i(oss_i, osm_i, it_i). \tag{2.2}$$

It is a function of wages, w_i, rental, r_i, material input prices, q_i^m, service input prices, q_i^s, and output. Outsourcing can affect the labor demand through three channels. First, there

[8] Most people would expect that learning externalities would go from the US to other countries rather than to the US, but it is in principle a possibility and there has been some evidence showing that US productivity increased as a result of inward FDI. See Keller and Yeaple (2004).

is a substitution effect through the input price of materials or services. A fall in the price of imported services would lead to a fall in the demand for labor if labor and services are substitutes. Second, if outsourcing leads to a productivity improvement then firms can produce the same amount of output with less inputs. Hence, conditional on a given level of output, outsourcing is expected to reduce the demand for labor. Third, outsourcing can affect labor demand through a scale effect. An increase in outsourcing can make the firm more efficient and competitive, increasing demand for its output and hence labor. To allow for the scale effect, we substitute in for the profit maximizing level of output, which is also a function of outsourcing, then the labor demand function is given by

$$L_i = g(w_i, r_i, q^m, q^s, p_i, oss_i, osm_i)/A_i(oss_i, osm_i), \tag{2.3}$$

where p_i is the price of the final output, which is also a function of factor prices. Now, outsourcing may have a positive or negative effect on employment depending on whether the scale effect outweighs the negative substitution and productivity effects.

2.2. Estimation

2.2.1. Productivity

Taking the log of equation 2.1, and denoting first differences by Δ, the estimating equation becomes

$$\begin{aligned} \Delta \ln Y_{it} = {} & \alpha_0 + \alpha_1 \Delta oss_{it} + \alpha_2 \Delta osm_{it} \\ & + \beta_1 \Delta \ln L_{it} + \beta_2 \Delta \ln K_{it} + \beta_3 \Delta \ln M_{it} + \beta_4 \Delta \ln S_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}. \end{aligned} \tag{2.4}$$

This first difference specification controls for any time invariant industry specific effects such as industry technology differences. In this time differenced specification, we also include year fixed effects, to control for any unobserved time-varying effect common across all industries that affect productivity growth, and in some specifications we also include industry fixed effects. Some industries may be pioneering industries that are high growth industries and hence more likely to outsource; and some industries might be subject to higher technical progress than others. Adding industry fixed effects to a time differenced equation takes account of these factors, provided the growth or technical progress is fairly constant over time. We estimate equations 2.4 using ordinary least squares, with robust standard errors corrected for clustering. We hypothesize that α_1 and α_2 are positive. We also include one period lags of the outsourcing variables to take account that productivity effects may not be instantaneous.[9]

[9] Longer lags were insignificant.

There are a number of econometric issues that will need to be addressed. First, the choice of inputs is endogenous. To address this, we will also estimate productivity as value added per worker. Since the dependent variable is redefined as real output less materials and services, divided by labor, the inputs would not be included as explanators. However, this does impose unitary coefficients on these inputs, which may be overly restrictive.

Second, there may also be a problem of potential endogeneity of outsourcing. More productive industries might self select into outsourcing. Conversely, firms that expect a fall in productivity growth might increase their level of outsourcing in the hope of increasing their productivity. Hence the bias could go either way. We use two-stage least squares to address this concern as well as GMM.

2.2.2. Employment

The conditional labor demand, equation 2.2, will also be estimated in first differences as a log-log specification as is common in the empirical literature (see Hamermesh (1993), and Hanson, Mataloni and Slaughter (2004)), as follows

$$\Delta \ln l_{it} = \gamma_0 + \gamma_1 \Delta oss_{it} + \gamma_2 \Delta osm_{it} + \gamma_3 \ln \Delta w_{it} + \gamma_4 \Delta \ln Y_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}. \tag{2.5}$$

The source of identification of employment in these type of industry labor demand studies is the assumption that the wage is exogenous to the industry. This would be the case if labor were mobile across industries. However, if labor were not perfectly mobile and there were industry specific rents then wages would not be exogenous. Provided these rents are unchanged over time then they would be absorbed in the industry fixed effects and the results would be unbiased.

In general, an increase in output would be expected to have a positive effect on employment and an increase in wages a negative effect; whereas an increase in the price of other inputs a positive effect if the inputs are gross substitutes.

The question arises as to which input prices to use for outsourcing. If the firm is a multinational firm deciding on how much labor to employ at home and abroad then it should be the foreign wage. But not all of outsourcing takes place within multinational firms and also with the US outsourcing from many countries it is unclear which foreign wage to include, if any. Firms that import inputs at arm's-length do not care about the foreign wage *per se* but instead are concerned about the price of the imported service. We assume that all firms face the same price for other inputs, such as imported inputs and the rental on capital, which we assume is some function of time, $r = f(t)$.[10] In this time differenced equation,

[10] Note that in Amiti and Wei (2005), which estimates a labor demand equation for the UK, the outsourcing

these input prices will be captured by the time fixed effects, δ_i. In a conditional demand function, we expect that if outsourcing increases productivity, then this will have a negative effect on the demand for labor since less inputs are needed to produce the same amount of output.

Substituting in the price of output for the quantity of output, we allow for scale effects,

$$\Delta \ln l_{it} = \gamma_0 + \gamma_1 \Delta oss_{it} + \gamma_2 \Delta osm_{it} + \gamma_3 \ln \Delta w_{it} + \gamma_5 \Delta \ln p_{it} + \delta_t D_t + \delta_i D_i + \varepsilon_{it}. \tag{2.6}$$

Now, it is unclear what the net effect of outsourcing is on labor demand (see equation 2.3) as it will depend on whether the scale effects are large enough to outweigh substitution and productivity effects. In some specifications we will estimate a more reduced form of 2.6, omitting p_{it}, which is a function of input prices.

We estimate equations 2.5 and 2.6 using ordinary least squares, with robust standard errors corrected for clustering.

3. Data and measurement of outsourcing

We estimate the effects of outsourcing on productivity and employment for the period 1992 to 2000. The outsourcing intensity of services (oss_i) for each industry is defined as the share of service inputs imported, and is calculated as Feenstra and Hanson (1996, 1999) do for material inputs, as follows:

$$oss_i = \sum_j \left[\frac{\text{input purchases of service } j \text{ by industry } i}{\text{total non-energy inputs used by industry } i} \right] * \left[\frac{\text{imports of service } j}{\text{production}_j + \text{imports}_j - \text{exports}_j} \right]. \tag{3.1}$$

The first square bracketed term is calculated using annul input/output tables from 1992 to 2000 constructed by the Bureau of Labor Statistics (BLS), based on the Bureau of Economic Analysis (BEA) 1992 benchmark tables. The BEA use SIC 1987 industry disaggregation, which consist of roughly 450 manufacturing industries. These are aggregated up to 96 BLS manufacturing codes by the BLS. We also include the following five service industries as inputs to the manufacturing industries: telecommunications, insurance, finance, business services, and computing and information. These service industries were aggregated up to

intensity is interpreted as an inverse proxy of the price of imported service inputs, i.e., the lower the price of imported service inputs the higher the outsourcing intensity. Similiarly, in this specification the outsourcing intenstity may be either picking up the productivity effect and/or the substitution effect.

match the IMF Balance of Payments statistics. Business services is the largest component of service inputs with an average share of 12% in 2000 ; then finance (2.4%); telecommunications (1.3%); insurance (0.5%); and the lowest share is computing and information (0.4%).

The second square bracketed term is calculated using international trade data from the IMF Balance of Payments annual yearbooks. Unfortunately, imports and exports of each input by industry are unavailable so an economy wide import share is applied to each industry. As an example, the US economy imported 2.2% of business services in 2000 – we then assume that each manufacturing industry imports 2.2% of its the business service that year. Thus, on average, the outsourcing intensity of business services is equal to 0.12*0.022=0.3%. We aggregate across the five service inputs to get the average service outsourcing intensity for each industry, oss_i. An analogous measure is constructed for material outsourcing, denoted osm_i.

Table 1 presents averages of outsourcing intensities of materials and services, weighted by industry output, plus two service outsourcing sub-categories, business services and computing. The average share of imported service inputs in 2000 is only 0.3 percent whereas the average share of imported material inputs is 17.4 percent. Both types of outsourcing have been increasing on average during the sample period, with higher growth rates for service outsourcing at an annual average of 6.3 percent compared to an average growth rate of 4.4 percent for materials. Outsourcing of computing services showed the highest average annual growth rate at 12.4 percent.

The breakdown of the two components of the outsourcing intensity ratio for each service category is provided for 1992 and 2000 in Table 2. The first column shows the average intensity of each service category (the first term in equation 3.1) and the last column gives the average import intensity of each service category (the second term in equation 3.1). We see from column 1 that business services is the largest service category used across manufacturing industries, and this has grown from an average of 9.7 percent in 1992 to 12 percent in 2000. There is also much variation between industries. For example, in 2000, in the "household audio and video equipment" industry business services only accounted for 2 percent of total inputs whereas in the "greeting cards" industry it was 45 percent. From the last column, we see that the import share of all service category, except communications, increased over the period.

There are a number of potential problems with these outsourcing measures that should be noted. First, they are likely to under-estimate the value of outsourcing because the cost of importing services is likely to be lower than the cost of purchasing them domestically. While it would be preferable to have quantity data rather than current values this is unavailable for the United States. Second, applying the same import share to all industries is not ideal, but given the unavailability of imports by industry this is our "best guess". The same strategy was used by Feenstra and Hanson (1996, 1999) to construct measures of material outsourcing. This approach apportions a higher value of imported inputs to the industries that are the biggest users of those inputs. Although this seems reasonable, without access to actual import data by industry it is impossible to say how accurate it is. Third, the total use of inputs by industry only includes those inputs purchased from a different industry so services produced within the industry are not included, hence the extent of outsourcing is unlikely to be precisely measured. Despite these limitations, we believe that combining the input use information with trade data provides a reasonable proxy of the proportion of services imported from abroad.

The BLS data sources are used for estimation of productivity to match the level of aggregation of the outsourcing ratios. However, capital stock was only available from the Annual Survey of Manufacturers (ASM) at the SIC level so needed to be aggregated up to the BLS level. We adopt the perpetual investment method to extend the capital stock series beyond 1996, using average depreciation rates that were applied in the NBER (Bartelsman and Gray, 1996) database: 7.7 percent depreciation for equipment and 3.5 percent for structures.

Productivity is only estimated at the BLS industry categories. We are unable to estimate the productivity effects at a more disaggregated level because service inputs are only available at the BLS codes and these need to be subtracted from output in order to ensure that productivity growth is not inflated in service-intenstive industries as an artifact of an omitted variable.

The employment equations are estimated at two different levels of aggregation: (i) BLS categories comprising 96 manufacturing industries; and (ii) SIC categories comprising 450 industries. In order to aid comparison between these different levels of aggregation, the employment equations all use data from the NBER Productivity database (Bartelsman and Gray, 1996) which provides input and output data at the 4-digit SIC level up to the year 1996. We extend this data to 2000 using the same sources as they do, which include the BEA and ASM, and the same methodology wherever possible. See Table A1 in the Appendix for details of the data sources. All the summary statistics are provided in Table 3.

4. Results

We estimate equations 2.4, 2.5 and 2.6 at the industry level for the period 1992 to 2000. All variables are entered in log first differences, except outsourcing which is the change in outsourcing intensity; and all estimations include year fixed effects and some specifications also include industry fixed effects. The errors have been corrected for clustering at the BLS level, which is the aggregation level of the outsourcing variables.

4.1. Productivity

The results from estimating equation 2.4 are presented in Table 4. Column 1 includes year fixed effects and column 2 includes year and industry fixed effects. Both columns show that service outsourcing and material outsourcing have a positive significant effect on total factor productivity. That is, holding all factors of production constant, increasing the share of international outsourcing leads to higher output. Note that this specification could result in biased estimates because of the endogeneity of input choices. To address this concern, we also estimate the effect of outsourcing on labor productivity, measured by value added per worker. This is calculated by taking the difference between real output and real materials and services, divided by employment. The results are presented in columns 3 to 5.

We see from column 3 that both service outsourcing and material outsourcing are positively correlated with labor productivity. In column 4 we add in the capital stock and find this result is unchanged.[11] It indicates that service outsourcing is positively correlated with labor productivity, and material outsourcing also has a significant positive effect but a somewhat smaller effect. In column 5 we add in industry effects and find that the size of the coefficients on service outsourcing are even larger, and both the contemporaneous and lagged variables are significant, however the material outsourcing becomes insignificant.

To get an idea of the magnitude of the effects, we calculate the total effect of service outsourcing on productivity by summing the coefficients on Δoss_t and Δoss_{t-1}, which equals 0.8, in the specification with industry effects in column 5. Outsourcing increased by 0.1 percentage point over the sample period, from 0.18 to 0.29 (see Table 1) so this implies that service outsourcing contributed to 8 percent of total growth in labor productivity or 1 percent annually. Given that value added per worker increased by an average of 40 percent over the sample period, this suggests that service outsourcing accounted for around 20 percent of the average growth in labor productivity.

4.1.1. Additional Controls

There may be concern that the service outsourcing measure is correlated with omitted variables such as high-technology capital or total imports, which may be inflating the coefficients on service outsourcing. To address this we include two measures of high technology capital as in Feenstra and Hanson (1999); and the share of imports by industry. The data for high-technology capital stock are estimates of the real stock of assets within two-digit SIC

[11] The results are the same with growth in capital per worker.

manufacturing industries, from the BLS. High-technology capital includes computers and peripheral equipment, software, communication equipment, office and accounting machinery, scientific and engineering instruments, and photocopy and related equipment. Each capital asset is then multiplied by its ex post rental price to obtain the share of high-tech capital services for each asset within each two-digit SIC industry (also estimated by BLS), and reflects the internal rate of return in each industry and capital gains on each asset. As an alternative, the capital stock components are multiplied by an ex ante measure of rental prices used by Berndt and Morrison(1995), where the Moody rate of Baa bonds is used to measure the ex ante interest rate and the capital gains term is excluded.

Column 1 in Table 5 includes the ex post rental high-tech capital share and column 2 includes the ex ante high-tech capital share. Neither of these measures are significant. We include import share, defined as the ratio of total imports to output by industry, in column 3. This shows that tougher import competition has a positive effect on labor productivity, but its inclusion leaves the effect of service outsourcing unchanged. In columns 4, 5 and 6 we add industry fixed effects. We see from column 4 that the ex post measure of high-tech capital is significant now at the 10% level whereas the ex ante measure remains insignificant. The import share with industry fixed effects, in column 6, becomes insignificant. Although the high-tech capital share, with industry fixed effects, has a positive effect on productivity it does not affect the size of the service outsourcing coefficients.

4.1.2. Sensitivity: Measurement Error

There is a risk that taking first time period differences could induce measurement error, particularly when the variables are aggregated at the industry level.[12] To address this concern, we re-estimate the equations using longer time differences to help wash out measurement error. In columns 1 to 3 of Table 6, the variables are in two period differences, and include industry fixed effects. We see that as in the previous table service outsourcing is positively correlated with labor productivity and material outsourcing is insignificant. The ex post high-tech capital measure[13] is now significant at the 5 percent level and import share has a negative significant effect on productivity. In the next three columns, all variables are calculated as the difference between the average of the first three years less the average of the last three years.[14] This averaging and differencing helps reduce measurement error and

[12] See Griliches and Hausman (1986).

[13] The ex ante measure is insignificant in all specifications so we only include the expost measure to conserve space.

[14] Two outliers, computing and electronics industries, were dropped from the long difference estimations because they had unusually high growth in value added that was unrelated to outsourcing. The computing industry experience growth in labor productivity 6 standard deviations higher than the mean and the

having only one observation per industry avoids any serial correlation, but this is at the cost of a much smaller number of observations. The technology and import share variables are now insignificant. Interestingly, in all of the specifications service outsourcing is positively correlated with labor productivity, and in these longer time differenced specifications so is material outsourcing but with much smaller coefficients.

4.1.3. Sensitivity: Endogeneity

Which industries engage in more outsourcing may not be random, and hence could lead to biased estimates. If the industries that self-select into outsourcing do not change over time then the industry effects should take account of this. However, if there is some time varying effect, then the bias might persist. In order to address this potential concern, we re-estimate the equations using instruments for service outsourcing and materials outsourcing. A good instrument is one that would only affect productivity through its effect on outsourcing.

Industries that rely more on services are more likely to respond to technology changes that reduce the cost of outsourcing. The cost of service outsourcing may be proxied by the number of internet users in the countries which supply the largest share of imported outsourcing type services to the US. To capture the idea that industries with high service usage may be more responsive to changes in the cost of international outsourcing, we interact each IT_{ct} with total services as a share of output at the beginning of the sample for each industry in the first stage regression, thus

$$oss_{it} = f\left(IT_{c,t} * \frac{services_{i,1992}}{output_{i,1992}}\right),$$

which provides us with c instruments that vary by industry and time. We also experiment with interactions with the proportion of business services and computing services in 1992.

The number of internet users are from the International Telecommunication Union (2003) Yearbook. To determine which countries' internet usage to include we turn to the BEA bilateral services trade statistics to identify the countries that supply the largest shares of services to the US. For the year 2000, these are Canada (24%), UK (20%), Japan (6%), and Germany (5%). We also add India, given the high publicity it has received, although the share of business imports originating in India are only 2%.

For material outsourcing, we use the average freight and insurance rate, FI_{it}, on US imports, averaged across all partner countries. Then for each industry i, this is weighted by the share of input j used in industry i, using weights from the input/output tables, a_{ij}.

electronics industry 5 standard deviations higher than the mean.

$$FI_{it} = \sum_j a_{ijt} * FI_{jt}$$

The results are presented in Table 7. In all of the specifications, the instruments for service outsourcing provide a reasonable fit in the first stage regressions as indicated by the Shea partial R-squared yet the fit for material outsourcing is somewhat lower;[15] and they all pass the overidentification tests with p-values ranging from 0.08 to 0.46, indicating that these are statistically valid instruments. We see that the net effect of service outsourcing on productivity remains positive and significant in all columns. In the first column internet usage by country is interacted with the service intensity in 1992, and in column 2 it is interacted with the large and small dummies that indicate the outsourcing intensity level at the beginning of the period. In column 3, we interact internet usage with the share of business services to output, and computing services to output in 1992 since these type of services are considered more likely to be outsourced. The sum of the coefficients on the contemporaneous and lagged outsourcing produce slightly higher outsourcing coefficients compared to the OLS results in columns 1 and 2, with the contemporaneous much smaller in size and the lagged term much higher. However, in column (3) the net effect is smaller. In the next three columns we add high-tech capital and import share. In all specifications service outsourcing has a positive effect on labor productivity; and material outsourcing an insignificant effect.

As a final robustness check we re-estimate the labor productivity equations using GMM analysis. We include the high-tech capital share and import share variables since we will instrument for all explanatory variables. The results, presented in Table 8, show that service outsourcing and high-tech capital have a positive significant effect on labor productivity, material outsourcing has an insignificant effect and imports have a negative effect. In all of the specifications, service outsourcing has a positive and significant effect on productivity whereas the positive effect from material outsourcing is not robust across all specifications.

4.2. Employment

The results from estimating the conditional demand function, equation 2.5 in column 1 of Table 9, show that service outsourcing has a negative effect on employment and material outsourcing has an insignificant effect. However, once we allow for scale effects in columns 2 and 3, the effect from service outsourcing becomes insignificant and the effect from material outsourcing positive and significant. This is also the case with industry fixed effects in

[15] This takes account of the collinearity between endogenous variables. For further details, see Shea (1996).

columns 4 to 6. This finding is consistent with Hanson, Mataloni and Slaughter (2003), which finds that labor demand by US foreign affiliates is complementary with labor demand in the US. Although high-tech capital has a negative effect on employment without industry effects, this disappears when we allow for scale effects and industry effects in columns 5 and 6.

The service outsourcing results are confirmed in the specifications with two period time differences in columns 1, 2 and 3 of Table 10, however material outsourcing is insignificant. In columns 4, 5 and 6 where all variables are entered in longer time differences, both service and material outsourcing are insignificant in all specifications. Robustness checks for potential endogeneity, using instrumental variables estimation and GMM as in the productivity specification, are presented in the Appendix. None of these specifications shows a negative significant effect from outsourcing on employment.

4.2.1. More disaggregated effects

It is likely that the more disaggregated the industry classifications the more likely it is that there could be a negative effect from outsourcing on employment even after taking account of scale effects. To see if this is the case, we re-estimate equation 2.5 and 2.6 using SIC categories of 450 manufacturing industries. But note that it was only possible to construct the outsourcing measures at the BLS classification comprising 96 industries, hence we cluster standard errors at the BLS industry category.

In fact, we do see a negative effect from service outsourcing on employment in Table 11 using the more disaggregated data, and this effect persists with two period differences in Table 12.[16] The total effect of service outsourcing is given by summing the coefficients on service outsourcing variables. Using estimates from column 3 in Table 11, the total effect from service outsourcing ($\Delta oss_t + \Delta oss_{t-1}$) on employment is equal to 0.37, at the 10 percent significance level. Since service outsourcing grew by 0.1 percentage point over the sample period, this implies a loss of 3.1% employment. However, weighted by employment shares this number falls to 0.4 of a percent.

[16] Robustness checks for potential endogeneity are presented in the Appendix. With instrumental variables, material and service outsourcing is insignificant in all sepcifications, but note that in many cases the instruments do not pass the overidentification tests. With GMM anlaysis service outsourcing is insignificant and material outsourcing has a positive effect on employment.

5. Conclusion

The increased practice of international outsourcing of services has led to concerns that jobs will be transferred from the US to developing countries. To see if these concerns have any foundation, we estimate the effects of service and material outsourcing on employment in the US between 1992 and 2000. We also estimate whether there are any benefits of outsourcing that manifest themselves through increased productivity. Our results show that service outsourcing has a significant positive effect in all our specifications. Material outsourcing has a positive effect but this is not robust across all specifications. We find there is a small negative effect of less than half a percent on employment when industries are finely disaggregated (450 manufacturing industries). However, this affect disappears at more aggregate industry level of 96 industries indicating that there is sufficient growth in demand in other industries within these broadly defined classifications to offset any negative effects.

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Table 1 Average Outsourcing Intensity: 1992-2000

	share of imported material inputs - OSM		share of imported service inputs - OSS		share of imported computing services - OSC		share of imported business services - OSB	
Year	%	%Δ	%	%Δ	%	%Δ	%	%Δ
1992	11.74		0.18		0.0009		0.14	
1993	12.73	5.41	0.18	4.87	0.0010	21.34	0.15	5.33
1994	13.45	4.99	0.20	6.39	0.0010	-6.86	0.16	7.29
1995	14.20	4.67	0.20	4.10	0.0011	15.18	0.16	4.79
1996	14.37	1.72	0.21	6.64	0.0017	43.06	0.17	6.54
1997	14.59	1.62	0.23	6.97	0.0025	35.02	0.18	8.36
1998	14.96	2.87	0.24	6.57	0.0025	0.22	0.20	8.60
1999	15.55	3.41	0.29	16.73	0.0020	-21.13	0.25	22.62
2000	17.41	10.39	0.29	-2.23	0.0023	12.60	0.25	-2.57
1992-2000		4.39		6.26		12.43		7.62

Note: Averages are weighted by industry outputs

Table 2 Outsourcing of Services Components: 1992 and 2000

Services	Share of Service Inputs				Import of Services
	Mean	Std Dev	Min	Max	
(1992)					
Communication	0.0116	0.0079	0.0025	0.0482	0.0247
Financial	0.0191	0.0063	0.0093	0.0472	0.0025
Insurance	0.0043	0.0018	0.0016	0.0139	0.0182
Other business service	0.0969	0.0716	0.0187	0.3793	0.0147
Computer and Information	0.0055	0.0044	0.0002	0.0253	0.0016
(2000)					
Communication	0.0127	0.0094	0.0028	0.0545	0.0118
Financial	0.0237	0.0086	0.0071	0.0528	0.0051
Insurance	0.0047	0.0022	0.0010	0.0136	0.0284
Other business service	0.1202	0.0855	0.0189	0.4499	0.0223
Computer and Information	0.0038	0.0031	0.0001	0.0201	0.0062

Source: BLS, Input-Output Tables and IMF, Balance of Payments Statistics Yearbook.

Table 3 Summary Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
(BLS level)					
oss %	832	0.2278	0.1460	0.0399	1.0175
Δoss %	736	0.0140	0.0272	-0.1446	0.2237
osm %	832	15.2672	9.8409	1.2198	69.2554
Δosm %	736	0.7152	1.9878	-16.1730	21.2201
value-added per worker	832	84,983	59,326	17,696	591,093
Δln(value-added per worker)	736	0.0436	0.0701	-0.2313	0.3638
price (1996 = 1.000)	832	0.9852	0.1011	0.3698	1.9956
Δln(price)	736	0.0104	0.0479	-0.3440	0.2784
(SIC aggregated to BLS)					
employment	832	180,213	157,992	4,936	838,385
Δln(employment)	736	-0.0005	0.0484	-0.2496	0.2541
wage	832	32,728	8,162	14,709	56,506
Δln(wage)	736	0.0299	0.0244	-0.0796	0.1464
real output, $1M	832	38,940	49,018	785	495,348
Δln(real output)	736	0.0318	0.0695	-0.3233	0.4424
capital stock	832	15,951	18,636	395	120,734
Δln(capital stock)	736	0.0299	0.0296	-0.0356	0.3013
import share %	823	26.6932	48.9221	0.0224	340.7584
Δ(import share) %	728	1.5036	5.0434	-37.5022	57.8835
(SIC 2 digit level)					
ex post rental prices					
htech %[1)]	171	8.8687	5.7488	2.5744	24.1124
Δhtech %	152	0.2556	0.8437	-2.8989	4.4102
ex ante rental prices					
htech %	169	8.6391	5.4305	2.5083	23.1493
Δhtech %	150	0.0934	0.3204	-0.7289	1.5115
(SIC 4 digit level)					
employment	4,054	37,287	54,290	100	555,063
Δln(employment)	3,598	-0.0084	0.0996	-1.9459	0.7368
wage	4,054	31,152	9,004	12,350	72,157
Δln(wage)	3,598	0.0308	0.0481	-0.2826	0.6219
real output, $1M	4,054	8,583	52,572	24	2,292,522
Δln(real output)	3,598	0.0221	0.1097	-1.1000	0.8644
price (1987 = 1.000)	4,057	1.2219	0.1772	0.0407	2.7979
Δln(price)	3,602	0.0116	0.0473	-0.4854	0.4055
import share %	3,934	38.2671	112.4511	0.0001	2,283.2710
Δimport share %	3,490	3.0826	26.7149	-320.3036	891.2738

Note: 1) htech is defined as (high-tech capital services / total capital services)

Table 4 Productivity

Dependent variable	$\Delta\ln(\text{real output})_t$		$\Delta\ln(\text{value added per worker})_t$		
	(1)	(2)	(3)	(4)	(5)
Δoss_t	0.240***	0.332***	0.261	0.248	0.401**
	(0.045)	(0.073)	(0.166)	(0.169)	(0.164)
Δoss_{t-1}	0.066	0.093***	0.338**	0.312*	0.434***
	(0.041)	(0.027)	(0.155)	(0.158)	(0.151)
Δosm_t	0.001*	0.001*	0.003	0.003	0.001
	(0.001)	(0.001)	(0.003)	(0.003)	(0.004)
Δosm_{t-1}	0.000	0.000	0.003**	0.003**	0.002
	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
$\Delta\ln(\text{capital})_t$	0.056*	0.005		0.239	0.142
	(0.032)	(0.050)		(0.239)	(0.226)
$\Delta\ln(\text{labor})_t$	0.041*	0.005			
	(0.022)	(0.027)			
$\Delta\ln(\text{materials})_t$	0.405***	0.444***			
	(0.033)	(0.043)			
$\Delta\ln(\text{services})_t$	0.546***	0.495***			
	(0.036)	(0.042)			
year fixed effects	yes	yes	yes	yes	yes
industry fixed effects	no	yes	no	no	yes
Joint significance tests					
$\Delta oss_t + \Delta oss_{t-1} = 0$	F(1,95)=20.78	F(1,95)=20.21	F(1,95)=4.81	F(1,95)=3.97	F(1,95)=11.72
	p-value=0.00	*p-value*=0.00	*p-value*=0.03	*p-value*=0.05	*p-value*=0.00
$\Delta osm_t + \Delta osm_{t-1} = 0$	F(1,95)=2.39	F(1,95)=2.08	F(1,95)=2.44	F(1,95)=2.54	F(1,95)=0.40
	p-value=0.13	*p-value*=0.15	*p-value*=0.12	*p-value*=0.11	*p-value*=0.53
Observations	640	640	640	640	640
R-squared	0.97	0.98	0.07	0.07	0.42

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 5 Productivity and Additional Controls

Dependent variable : Δln(value added per worker)$_t$						
	(1)	(2)	(3)	(4)	(5)	(6)
Δoss_t	0.235	0.253	0.234	0.396**	0.413**	0.409***
	(0.177)	(0.167)	(0.165)	(0.168)	(0.162)	(0.155)
Δoss_{t-1}	0.307*	0.316*	0.321**	0.436***	0.443***	0.435***
	(0.155)	(0.160)	(0.156)	(0.140)	(0.148)	(0.139)
Δosm_t	0.003	0.003	0.005	0.001	0.002	0.003
	(0.003)	(0.004)	(0.003)	(0.004)	(0.004)	(0.003)
Δosm_{t-1}	0.003**	0.003**	0.003**	0.001	0.002*	0.002*
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Δln(capital)$_t$	0.234	0.255	0.254	0.131	0.166	0.085
	(0.244)	(0.249)	(0.247)	(0.231)	(0.225)	(0.229)
Δ(htech)$_t$	0.001			0.003		0.003
(*ex post rental prices*)	(0.003)			(0.003)		(0.003)
Δ(htech)$_{t-1}$	0.005			0.009*		0.009*
(*ex post rental prices*)	(0.005)			(0.005)		(0.005)
Δ(htech)$_t$		-0.007			-0.010	
(*ex ante rental prices*)		(0.019)			(0.015)	
Δ(htech)$_{t-1}$		-0.001			-0.001	
(*ex ante rental prices*)		(0.011)			(0.012)	
Δ(impshare)$_t$			-0.001			-0.003
			(0.001)			(0.002)
Δ(impshare)$_{t-1}$			0.002**			-0.000
			(0.001)			(0.001)
year fixed effects	yes	yes	yes	yes	yes	yes
industry fixed effects	no	no	no	yes	yes	yes
Joint significance tests						
$\Delta oss_t + \Delta oss_{t-1} = 0$	F(1,95)=3.56	F(1,95)=4.08	F(1,94)=3.94	F(1,95)=12.56	F(1,95)=12.85	F(1,94)=14.63
	p-value=0.06	*p-value*=0.05	*p-value*=0.05	*p-value*=0.00	*p-value*=0.00	*p-value*=0.00
$\Delta osm_t + \Delta osm_{t-1} = 0$	F(1,95)=2.25	F(1,95)=2.32	F(1,95)=4.26	F(1,95)=0.23	F(1,95)=0.68	F(1,95)=1.97
	p-value=0.14	*p-value*=0.13	*p-value*=0.04	*p-value*=0.64	*p-value*=0.41	*p-value*=0.16
Δ(htech)$_t$+Δ(htech)$_{t-1}$ = 0	F(1,95)=0.48			F(1,95)=2.92		
(*ex post rental prices*)	*p-value*=0.49			*p-value*=0.09		
Δ(htech)$_t$+Δ(htech)$_{t-1}$ = 0		F(1,95)=0.16			F(1,95)=0.57	
(*ex ante rental prices*)		*p-value*=0.69			*p-value*=0.45	
Δ(impshare)$_t$ +			F(1,95)=0.05			F(1,95)=2.64
Δ(impshare)$_{t-1}$ = 0			*p-value*=0.82			*p-value*=0.11
Observations	640	636	633	640	636	633
R-squared	0.08	0.08	0.09	0.43	0.44	0.45

Notes : 1) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
2) htech using *ex ante* rental prices are missing for BLS=108, 109 and years 1992, 1993. Also, import shares for BLS=36 are missing.

Table 6 Labor Productivity, Long Period Differences

Dependent variable : ln(value-added per worker)$_t$ - ln(value-added per worker)$_{t-k}$						
	2 period difference			8 period differerence[1]		
	(1)	(2)	(3)	(4)	(5)	(6)
Δoss_t	0.045	0.072	0.091	0.669**	0.656**	0.648**
	(0.252)	(0.264)	(0.259)	(0.302)	(0.305)	(0.310)
Δoss_{t-1}	0.625***	0.593***	0.600***			
	(0.117)	(0.113)	(0.105)			
Δosm_t	0.001	0.001	0.003	0.029***	0.030***	0.029***
	(0.004)	(0.004)	(0.003)	(0.007)	(0.007)	(0.010)
Δosm_{t-1}	0.001	0.000	0.000			
	(0.002)	(0.002)	(0.002)			
Δln(capital)$_t$	0.155	0.195	0.107	0.050	0.048	0.058
	(0.252)	(0.257)	(0.258)	(0.095)	(0.096)	(0.103)
Δ(htech)$_t$		-0.004	-0.004		0.005	0.004
(*ex post rental prices*)		(0.005)	(0.005)		(0.010)	(0.011)
Δ(htech)$_{t-1}$		0.011**	0.012**			
(*ex post rental prices*)		(0.006)	(0.005)			
Δ(impshare)$_t$			-0.003**			0.000
			(0.001)			(0.001)
Δ(impshare)$_{t-1}$			0.000			
			(0.001)			
year fixed effects	yes	yes	yes	no	no	no
industry fixed effects	yes	yes	yes	no	no	no
Joint significance tests						
$\Delta oss_t + \Delta oss_{t-1} = 0$	F(1,95)=4.85	F(1,95)=4.50	F(1,95)=5.11			
	p-value=0.03	*p-value*=0.04	*p-value*=0.03			
$\Delta osm_t + \Delta osm_{t-1} = 0$	F(1,95)=0.10	F(1,95)=0.03	F(1,95)=0.40			
	p-value=0.76	*p-value*=0.86	*p-value*=0.53			
Δ(htech)$_t$ + Δ(htech)$_{t-1}$ = 0		F(1,95)=0.72	F(1,95)=0.92			
(*ex post rental prices*)		*p-value*=0.40	*p-value*=0.34			
Δ(impshare)$_t$+			F(1,95)=3.09			
Δ(impshare)$_{t-1}$ = 0			*p-value*=0.08			
Observations	545	545	539	87	87	86
R-squared	0.64	0.65	0.68	0.19	0.19	0.19

Notes: 1) Variables in columns (4) to (6) are the difference between the average of the first three and last three years. Two industries, electronic components and computer and office equipment were dropped – these were large outliers with unusually high labor productivity growth unrelated to outsourcing.
2) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
3) Import shares for BLS=36 are missing.

Table 7 Labor Productivity – Instrumental Variables

Dependent variable : Δln(value added per worker)$_t$				
	(1)	(2)	(3)	(4)
Δoss_t	0.349	0.237	0.229	0.242
	(0.290)	(0.284)	(0.281)	(0.290)
Δoss_{t-1}	0.840**	0.733**	0.836**	0.785**
	(0.350)	(0.356)	(0.333)	(0.332)
Δosm_t	0.008	0.006	0.009	0.010
	(0.009)	(0.010)	(0.011)	(0.010)
Δosm_{t-1}	0.006	0.015*	0.006	0.016**
	(0.009)	(0.008)	(0.010)	(0.008)
Δln(capital)$_t$	0.112	0.041	0.061	-0.037
	(0.196)	(0.207)	(0.200)	(0.203)
Δ(htech)$_t$			0.002	0.002
(*ex post rental prices*)			(0.004)	(0.004)
Δ(htech)$_{t-1}$			0.008*	0.006
(*ex post rental prices*)			(0.004)	(0.004)
Δ(impshare)$_t$			-0.003*	-0.003**
			(0.002)	(0.002)
Δ(impshare)$_{t-1}$			0.000	-0.001
			(0.001)	(0.001)
year fixed effects	yes	yes	yes	yes
industry fixed effects	yes	yes	yes	yes
Instrument variables				
$IT_{c,t}$ interacted with :	service intensity 1992	business & computing service intensity 1992.	service intensity 1992	business & computing service intensity 1992.
Joint significance tests				
$\Delta oss_t + \Delta oss_{t-1} = 0$	$\chi^2(1)$=4.44	$\chi^2(1)$=3.13	$\chi^2(1)$=4.22	$\chi^2(1)$=3.95
	p-value=0.04	*p-value*=0.08	*p-value*=0.04	*p-value*=0.05
$\Delta osm_t + \Delta osm_{t-1} = 0$	$\chi^2(1)$=0.81	$\chi^2(1)$=1.98	$\chi^2(1)$=0.63	$\chi^2(1)$=2.78
	p-value=0.37	*p-value*=0.16	*p-value*=0.43	*p-value*=0.10
Δ(htech)$_t$+Δ(htech)$_{t-1}$=0			$\chi^2(1)$=1.98	$\chi^2(1)$=1.12
(*ex post rental prices*)			*p-value*=0.16	*p-value*=0.29
Δ(impshare)$_t$+Δ(impshare)$_{t-1}$=0			$\chi^2(1)$=2.58	$\chi^2(1)$=3.68
			p-value=0.11	*p-value*=0.06
Shea Partial R^2 :				
Δoss_t	0.121	0.123	0.133	0.134
Δoss_{t-1}	0.108	0.126	0.103	0.132
Δosm_t	0.025	0.032	0.018	0.030
Δosm_{t-1}	0.018	0.027	0.015	0.029
Hansen J statistic	5.665	7.828	5.253	7.157
	$\chi^2(3)$=0.13	$\chi^2(8)$=0.45	$\chi^2(3)$=0.15	$\chi^2(8)$=0.52
Observations	640	640	633	633

Notes : 1) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
2) Import shares for BLS=36 are missing**.**

Table 8 Labor Productivity - GMM Analysis

Dependent variable : $\Delta\ln(\text{value added per worker})_t$			
	(1)	(2)	(3)
$\Delta(\text{vaw})_{t-1}$	-0.191***	-0.186***	-0.261***
	(0.063)	(0.064)	(0.069)
Δoss_t	0.419***	0.410***	0.370***
	(0.127)	(0.126)	(0.104)
Δoss_{t-1}	0.499***	0.500***	0.469***
	(0.120)	(0.117)	(0.120)
Δosm_t	-0.002	-0.002	0.002
	(0.005)	(0.005)	(0.004)
Δosm_{t-1}	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)
$\Delta\ln(\text{capital})_t$	0.156	0.140	0.152
	(0.264)	(0.265)	(0.259)
$\Delta\ln(\text{capital})_{t-1}$	-0.394**	-0.421**	-0.402**
	(0.194)	(0.206)	(0.194)
$\Delta(\text{htech})_t$		0.006*	0.004
(*ex post rental prices*)		(0.003)	(0.003)
$\Delta(\text{htech})_{t-1}$		0.010**	0.008**
(*ex post rental prices*)		(0.004)	(0.004)
$\Delta(\text{impshare})_t$			-0.003*
			(0.002)
$\Delta(\text{impshare})_{t-1}$			-0.001*
			(0.001)
Joint significance tests			
$\Delta\text{oss}_t + \Delta\text{oss}_{t-1} = 0$	$\chi^2(1)$=32.42	$\chi^2(1)$=33.88	$\chi^2(1)$=38.47
	p-value=0.00	*p-value*=0.00	*p-value*=0.00
$\Delta\text{osm}_t + \Delta\text{osm}_{t-1} = 0$	$\chi^2(1)$=0.03	$\chi^2(1)$=0.06	$\chi^2(1)$=0.58
	p-value=0.86	*p-value*=0.81	*p-value*=0.45
$\Delta(\text{htech})_t + \Delta(\text{htech})_{t-1} = 0$		$\chi^2(1)$=5.11	$\chi^2(1)$=4.15
(*ex post rental prices*)		*p-value*=0.02	*p-value*=0.04
$\Delta(\text{impshare})_t + \Delta(\text{impshare})_{t-1} = 0$			$\chi^2(1)$=4.29
			p-value=0.04
Sargan test			
	$\chi^2(20)$=29.88	$\chi^2(20)$=28.32	$\chi^2(20)$=29.61
	p-value=0.07	*p-value*=0.10	*p-value*=0.08
H_0 : no 2nd order autocorrelation			
	z = 0.13	z = 0.01	z = 0.67
	p-value=0.90	*p-value*=0.99	*p-value*=0.50
Observations	541	541	535

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table 9 Employment and Outsourcing

Dependent variable : $\Delta\ln(\text{employment})_t$						
	(1)	(2)	(3)	(4)	(5)	(6)
Δoss_t	-0.002	-0.086	-0.067	0.005	-0.018	-0.017
	(0.080)	(0.124)	(0.129)	(0.062)	(0.105)	(0.109)
Δoss_{t-1}	-0.135*	-0.050	-0.070	-0.163	0.047	-0.001
	(0.073)	(0.073)	(0.071)	(0.105)	(0.075)	(0.071)
Δosm_t	0.002	0.003*	0.003**	0.002	0.003*	0.003*
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Δosm_{t-1}	0.001	0.002*	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta\ln(\text{wage})_t$	-0.543***	-0.369***	-0.371***	-0.542***	-0.382***	-0.381***
	(0.093)	(0.118)	(0.117)	(0.093)	(0.113)	(0.114)
$\Delta\ln(\text{wage})_{t-1}$	0.085	0.183**	0.184**	0.065	0.177**	0.174**
	(0.083)	(0.091)	(0.090)	(0.070)	(0.084)	(0.083)
$\Delta\ln(\text{real output})_t$	0.358***			0.491***		
	(0.068)			(0.059)		
$\Delta\ln(\text{real output})_{t-1}$	-0.034			0.060		
	(0.068)			(0.040)		
$\Delta\ln(\text{price})_t$		-0.019			0.033	
		(0.036)			(0.046)	
$\Delta\ln(\text{price})_{t-1}$		0.066			0.087	
		(0.043)			(0.052)	
$\Delta(\text{htech})_t$	-0.002	-0.004*	-0.004*	-0.001	-0.002	-0.003
(*ex post rental prices*)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
$\Delta(\text{htech})_{t-1}$	-0.005*	-0.005*	-0.005*	-0.004*	-0.003	-0.004
(*ex post rental prices*)	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
$\Delta(\text{impshare})_t$	-0.001*	-0.003***	-0.003***	0.000	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.001)	(0.001)
$\Delta(\text{impshare})_{t-1}$	-0.001**	-0.001***	-0.001**	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)
year fixed effects	yes	yes	yes	yes	yes	Yes
industry fixed effects	no	no	no	yes	yes	Yes
Joint significance tests						
$\Delta oss_t + \Delta oss_{t-1} = 0$	F(1,94)=1.69	F(1,94)=0.72	F(1,94)=0.72	F(1,94)=1.85	F(1,94)=0.06	F(1,94)=0.03
	p-value=0.20	*p-value*=0.40	*p-value*=0.40	*p-value*=0.18	*p-value*=0.81	*p-value*=0.86
$\Delta osm_t + \Delta osm_{t-1} = 0$	F(1,94)=1.81	F(1,94)=4.20	F(1,94)=3.98	F(1,94)=1.32	F(1,94)=3.16	F(1,94)=2.74
	p-value=0.18	*p-value*=0.04	*p-value*=0.05	*p-value*=0.25	*p-value*=0.08	*p-value*=0.10
$\Delta(\text{htech})_t+\Delta(\text{htech})_{t-1}=0$	F(1,94)=2.53	F(1,94)=3.65	F(1,94)=3.88	F(1,94)=1.56	F(1,94)=0.95	F(1,94)=1.51
(*ex post rental prices*)	*p-value*=0.12	*p-value*=0.06	*p-value*=0.05	*p-value*=0.21	*p-value*=0.33	*p-value*=0.22
$\Delta(\text{impshare})_t +$	F(1,94)=9.24	F(1,94)=42.97	F(1,94)=43.94	F(1,94)=0.74	F(1,94)=8.50	F(1,94)=8.49
$\Delta(\text{impshare})_{t-1} = 0$	*p-value*=0.00	*p-value*=0.00	*p-value*=0.00	*p-value*=0.39	*p-value*=0.00	*p-value*=0.00
Observations	633	633	633	633	633	633
R-squared	0.39	0.19	0.19	0.63	0.44	0.44

Notes: 1) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
2) Import shares for BLS=36 are missing.

Table 10 Employment and Outsourcing: Long Period Differences

Dependent variable : $\ln(\text{employment})_t - \ln(\text{employment})_{t-k}$						
	2 period difference			8 period differerence		
	(1)	(2)	(3)	(4)	(5)	(6)
Δoss_t	0.054	-0.092	-0.108	-0.102	-0.186	-0.186
	(0.075)	(0.127)	(0.131)	(0.347)	(0.406)	(0.400)
Δoss_{t-1}	-0.190*	0.080	0.042			
	(0.104)	(0.093)	(0.086)			
Δosm_t	0.000	0.000	0.000	0.005	0.013	0.012
	(0.000)	(0.000)	(0.000)	(0.007)	(0.009)	(0.009)
Δosm_{t-1}	0.001	-0.000	-0.000			
	(0.001)	(0.001)	(0.001)			
$\Delta \ln(\text{wage})_t$	-0.640***	-0.474***	-0.468***	-0.133	0.361	0.358
	(0.140)	(0.155)	(0.157)	(0.461)	(0.440)	(0.436)
$\Delta \ln(\text{real output})_t$	0.488***			0.211*		
	(0.070)			(0.116)		
$\Delta \ln(\text{price})_t$		0.088			0.028	
		(0.057)			(0.046)	
$\Delta(\text{htech})_t$	0.000	-0.003	-0.003	-0.013	-0.005	-0.005
(*ex post rental prices*)	(0.003)	(0.004)	(0.004)	(0.009)	(0.010)	(0.010)
$\Delta(\text{htech})_{t-1}$	-0.004*	-0.004	-0.004			
(*ex post rental prices*)	(0.002)	(0.004)	(0.004)			
$\Delta(\text{impshare})_t$	0.001	-0.002**	-0.002**	-0.004***	-0.005***	-0.005***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta(\text{impshare})_{t-1}$	-0.001	-0.001	-0.001			
	(0.001)	(0.001)	(0.001)			
year fixed effects	yes	yes	yes	no	no	no
industry fixed effects	yes	yes	yes	no	no	no
Joint significance tests						
$\Delta oss_t + \Delta oss_{t-1} = 0$	$F(1,94)=1.23$	$F(1,94)=0.01$	$F(1,94)=0.24$			
	p-value=0.27	*p-value*=0.93	*p-value*=0.62			
$\Delta osm_t + \Delta osm_{t-1} = 0$	$F(1,94)=0.18$	$F(1,94)=0.03$	$F(1,94)=0.06$			
	p-value=0.68	*p-value*=0.87	*p-value*=0.81			
$\Delta(\text{htech})_t+\Delta(\text{htech})_{t-1}= 0$	$F(1,94)=1.02$	$F(1,94)=1.41$	$F(1,94)=1.90$			
(*ex post rental prices*)	*p-value*=0.31	*p-value*=0.24	*p-value*=0.17			
$\Delta(\text{impshare})_t +$	$F(1,94)=0.04$	$F(1,94)=14.32$	$F(1,94)=14.04$			
$\Delta(\text{impshare})_{t-1} = 0$	*p-value*=0.84	*p-value*=0.00	*p-value*=0.00			
Observations	627	627	627	88	88	88
R-squared	0.74	0.60	0.60	0.35	0.25	0.25

Notes: 1) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
2) Import share for BLS=36 are missing.

Table 11 Employment and Outsourcing
More disaggregated Manufacturing Industries (450 industries- SIC)

Dependent variable : $\Delta \ln(\text{employment})_t$						
	(1)	(2)	(3)	(4)	(5)	(6)
Δoss_t	0.007	-0.155	-0.158	0.064	-0.002	-0.021
	(0.131)	(0.216)	(0.213)	(0.104)	(0.181)	(0.181)
Δoss_{t-1}	-0.212***	-0.128	-0.150*	-0.188***	-0.027	-0.066
	(0.069)	(0.078)	(0.078)	(0.057)	(0.063)	(0.056)
Δosm_t	0.001	-0.000	-0.000	0.002	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
Δosm_{t-1}	-0.000	-0.001	-0.002	0.001	-0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$\Delta \ln(\text{wage})_t$	-0.661***	-0.529***	-0.528***	-0.631***	-0.500***	-0.496***
	(0.080)	(0.091)	(0.091)	(0.083)	(0.094)	(0.094)
$\Delta \ln(\text{wage})_{t-1}$	0.012	0.048	0.048	0.038	0.076**	0.077**
	(0.039)	(0.035)	(0.035)	(0.038)	(0.033)	(0.033)
$\Delta \ln(\text{real output})_t$	0.510***			0.531***		
	(0.040)			(0.028)		
$\Delta \ln(\text{real output})_{t-1}$	0.032			0.050***		
	(0.028)			(0.016)		
$\Delta \ln(\text{price})_t$		0.063			0.111***	
		(0.041)			(0.042)	
$\Delta \ln(\text{price})_{t-1}$		0.055			0.068	
		(0.053)			(0.061)	
$\Delta(\text{htech})_t$	-0.004	-0.006*	-0.006*	-0.002	-0.004	-0.004
(*ex post rental prices*)	(0.002)	(0.003)	(0.003)	(0.002)	(0.004)	(0.004)
$\Delta(\text{htech})_{t-1}$	-0.008**	-0.009***	-0.009***	-0.006**	-0.006*	-0.007**
(*ex post rental prices*)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\Delta(\text{impshare})_t$	-0.000	-0.001***	-0.001***	-0.000	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\Delta(\text{impshare})_{t-1}$	-0.000	-0.000	-0.000	0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
year fixed effects	yes	yes	yes	yes	yes	yes
industry fixed effects	no	no	no	yes	yes	yes
Joint significance tests						
$\Delta oss_t + \Delta oss_{t-1} = 0$	F(1,94)=1.51	F(1,94)=1.28	F(1,94)=1.56	F(1,94)=1.20	F(1,94)=0.03	F(1,94)=0.26
	p-value=0.22	*p-value*=0.26	*p-value*=0.22	*p-value*=0.28	*p-value*=0.87	*p-value*=0.61
$\Delta osm_t + \Delta osm_{t-1} = 0$	F(1,94)=0.27	F(1,94)=0.38	F(1,94)=0.63	F(1,94)=2.23	F(1,94)=0.08	F(1,94)=0.01
	p-value=0.61	*p-value*=0.54	*p-value*=0.43	*p-value*=0.14	*p-value*=0.78	*p-value*=0.94
$\Delta(\text{htech})_t+\Delta(\text{htech})_{t-1}=0$	F(1,94)=4.74	F(1,94)=6.88	F(1,94)=6.95	F(1,94)=2.91	F(1,94)=2.85	F(1,94)=3.25
(*ex post rental prices*)	*p-value*=0.03	*p-value*=0.01	*p-value*=0.01	*p-value*=0.09	*p-value*=0.09	*p-value*=0.07
$\Delta(\text{impshare})_t$ +	F(1,94)=5.46	F(1,94)=35.12	F(1,94)=35.60	F(1,94)=0.08	F(1,94)=26.41	F(1,94)=27.07
$\Delta(\text{impshare})_{t-1} = 0$	*p-value*=0.02	*p-value*=0.00	*p-value*=0.00	*p-value*=0.77	*p-value*=0.00	*p-value*=0.00
Observations	3,046	3,046	3,046	3,046	3,046	3,046
R-squared	0.43	0.14	0.14	0.55	0.32	0.32

Notes: 1) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
2) There are 13 SICs with missing impshare, and several SICs that has missing employment for different years.

Table 12 Employment and Outsourcing: Long Period Differences
More disaggregated Manufacturing Industries (450 industries- SIC)

Dependent variable : $\ln(\text{employment})_t - \ln(\text{employment})_{t-k}$						
	2 period difference			8 period differerence		
	(1)	(2)	(3)	(4)	(5)	(6)
Δoss_t	-0.210**	-0.186	-0.213	-0.261	-0.622	-0.623
	(0.085)	(0.139)	(0.137)	(0.392)	(0.552)	(0.549)
Δoss_{t-1}	-0.148	-0.081	-0.097			
	(0.100)	(0.067)	(0.064)			
Δosm_t	0.001	0.000	0.000	-0.018*	-0.020	-0.021
	(0.001)	(0.002)	(0.002)	(0.010)	(0.014)	(0.013)
Δosm_{t-1}	-0.001	-0.001	-0.001			
	(0.001)	(0.001)	(0.001)			
$\Delta\ln(\text{wage})_t$	-0.522***	-0.481***	-0.478***	-0.829***	-0.765***	-0.768***
	(0.077)	(0.088)	(0.087)	(0.231)	(0.254)	(0.256)
$\Delta\ln(\text{real output})_t$	0.430***			0.477***		
	(0.033)			(0.123)		
$\Delta\ln(\text{price})_t$		0.091			0.046	
		(0.071)			(0.085)	
$\Delta(\text{htech})_t$	-0.007*	-0.008	-0.009*	-0.020	-0.026*	-0.027*
(*ex post rental prices*)	(0.004)	(0.005)	(0.005)	(0.012)	(0.014)	(0.014)
$\Delta(\text{htech})_{t-1}$	-0.010***	-0.008**	-0.009**			
(*ex post rental prices*)	(0.003)	(0.004)	(0.004)			
$\Delta(\text{impshare})_t$	-0.000***	-0.001***	-0.001***	-0.000	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\Delta(\text{impshare})_{t-1}$	-0.000**	0.000	0.000			
	(0.000)	(0.000)	(0.000)			
year fixed effects	yes	yes	yes	no	No	no
industry fixed effects	yes	yes	yes	no	No	no
Joint significance tests						
$\Delta oss_t + \Delta oss_{t-1} = 0$	F(1,94)=5.52	F(1,94)=2.11	F(1,94)=3.07			
	p-value=0.02	*p-value*=0.15	*p-value*=0.08			
$\Delta osm_t + \Delta osm_{t-1} = 0$	F(1,94)=0.02	F(1,94)=0.13	F(1,94)=0.24			
	p-value=0.89	*p-value*=0.72	*p-value*=0.63			
$\Delta(\text{htech})_t+\Delta(\text{htech})_{t-1}=0$	F(1,94)=6.42	F(1,94)=5.03	F(1,94)=5.26			
(*ex post rental prices*)	*p-value*=0.01	*p-value*=0.03	*p-value*=0.02			
$\Delta(\text{impshare})_t +$	F(1,94)=20.14	F(1,94)=24.04	F(1,94)=24.48			
$\Delta(\text{impshare})_{t-1} = 0$	*p-value*=0.00	*p-value*=0.00	*p-value*=0.00			
Observations	2,605	2,605	2,605	434	434	434
R-squared	0.54	0.47	0.47	0.47	0.18	0.18

Notes: 1) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
2) There are 13 SICs with missing impshare, and several SICs that has missing employment for different years.

Appendix

Table A1 : Data Sources

Variable	Code	Years available	Source
Input/output tables	BLS	1992 to 2000	BLS
Trade (Manufacturing)	HS10 digit	1992 to 2001	Feenstra
Trade (Services)	Balance of Payments	1992 to 2001	IMF
Output (Manufacturing)	SIC 4 digit	1992 to 2001	BEA
Output (Services)	SIC 3 digit	1992 to 2001	BEA
Value-Added per worker	BLS	1992 to 2000	BLS
Employment	SIC 4 digit	1992 to 2001	ASM
Payroll	SIC 4 digit	1992 to 2001	ASM
Capital stock	SIC 4 digit	1992 to 1996	NBER Productivity database
	SIC 4 digit	1996 to 2001	Constructed using investment perpetual method
Capital expenditure	SIC 4 digit	1996 to 2001	ASM
Investment deflators	SIC 2 digit	1996 to 2001	BLS
Materials	SIC 4 digit	1992 to 2001	ASM
Material deflators	SIC 4 digit	1992 to 1996	NBER Productivity database
	SIC 4 digit	1997 to 2001	BEA output deflators with 1992 BEA I/O table

Table A2 Employment and Outsourcing: Instrumental Variables

Dependent variable : $\Delta\ln(\text{employment})_t$	Conditional labor demand			Unconditional labor demand		
	(1)	(2)	(3)	(4)	(5)	(6)
Δoss_t	-0.074	-0.062	-0.033	-0.116	-0.134	-0.069
	(0.210)	(0.191)	(0.195)	(0.323)	(0.275)	(0.311)
Δoss_{t-1}	-0.276	-0.364	-0.183	0.230	0.166	0.319
	(0.182)	(0.223)	(0.164)	(0.265)	(0.313)	(0.216)
Δosm_t	-0.003	-0.003	-0.000	-0.001	-0.005	0.001
	(0.005)	(0.006)	(0.004)	(0.007)	(0.007)	(0.005)
Δosm_{t-1}	0.006	0.009	0.005	0.008	0.011	0.007
	(0.008)	(0.007)	(0.005)	(0.009)	(0.008)	(0.006)
$\Delta\ln(\text{wage})_t$	-0.506***	-0.494***	-0.515***	-0.392***	-0.376***	-0.404***
	(0.079)	(0.081)	(0.076)	(0.105)	(0.109)	(0.100)
$\Delta\ln(\text{wage})_{t-1}$	0.103	0.109	0.099	0.234**	0.248***	0.229***
	(0.081)	(0.080)	(0.074)	(0.093)	(0.091)	(0.086)
$\Delta\ln(\text{real output})_t$	0.479***	0.487***	0.478***			
	(0.044)	(0.046)	(0.041)			
$\Delta\ln(\text{real output})_{t-1}$	0.064*	0.064*	0.064**			
	(0.033)	(0.034)	(0.032)			
$\Delta\ln(\text{price})_t$				0.005	-0.028	0.035
				(0.111)	(0.126)	(0.098)
$\Delta\ln(\text{price})_{t-1}$				0.213**	0.247**	0.199**
				(0.103)	(0.098)	(0.079)
year fixed effects	yes	yes	yes	yes	yes	yes
industry fixed effects	yes	yes	yes	yes	yes	yes
Instrument variables						
$IT_{c,t}$ interacted with :	service intensity 1992	high/low oss intensity	business & computing service intensity 1992.	service intensity 1992	high/low oss intensity	business & computing service intensity 1992.
Joint significance tests						
$\Delta oss_t + \Delta oss_{t-1} = 0$	$\chi^2(1)$=1.19 *p-value*=0.27	$\chi^2(1)$=1.61 *p-value*=0.20	$\chi^2(1)$=0.53 *p-value*=0.47	$\chi^2(1)$=0.05 *p-value*=0.82	$\chi^2(1)$=0.00 *p-value*=0.95	$\chi^2(1)$=0.31 *p-value*=0.58
$\Delta osm_t + \Delta osm_{t-1} = 0$	$\chi^2(1)$=0.11 *p-value*=0.74	$\chi^2(1)$=0.28 *p-value*=0.60	$\chi^2(1)$=0.54 *p-value*=0.46	$\chi^2(1)$=0.29 *p-value*=0.59	$\chi^2(1)$=0.18 *p-value*=0.67	$\chi^2(1)$=0.82 *p-value*=0.37
Shea Partial R^2 :						
Δoss_t	0.119	0.116	0.121	0.118	0.122	0.133
Δoss_{t-1}	0.105	0.087	0.124	0.064	0.058	0.107
Δosm_t	0.025	0.030	0.032	0.016	0.020	0.031
Δosm_{t-1}	0.017	0.027	0.025	0.014	0.023	0.029
Hansen J statistic	17.90	18.38	20.89	8.89	13.79	10.34
	$\chi^2(3)$=0.00	$\chi^2(8)$=0.02	$\chi^2(8)$=0.01	$\chi^2(3)$=0.03	$\chi^2(8)$=0.09	$\chi^2(8)$=0.24
Observations	640	640	640	640	640	640

Note: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table A3 Employment and Outsourcing: IV and GMM

Dependent variable : Δln(employment)$_t$						
		IV[1]			GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
Δln(employment)$_{t-1}$				0.075	0.157**	0.159**
				(0.050)	(0.066)	(0.065)
Δoss$_t$	-0.183	-0.168	-0.133	0.012	0.033	0.056
	(0.317)	(0.261)	(0.300)	(0.069)	(0.119)	(0.128)
Δoss$_{t-1}$	0.171	0.024	0.206	-0.159**	0.018	0.006
	(0.282)	(0.330)	(0.190)	(0.077)	(0.073)	(0.068)
Δosm$_t$	0.000	-0.006	-0.000	0.004**	0.005***	0.005***
	(0.009)	(0.009)	(0.005)	(0.002)	(0.001)	(0.001)
Δosm$_{t-1}$	0.013	0.013	0.006	0.001	0.001	0.001
	(0.010)	(0.009)	(0.005)	(0.001)	(0.001)	(0.001)
Δln(wage)$_t$	-0.358***	-0.353***	-0.382***	-0.450***	-0.310***	-0.311***
	(0.102)	(0.106)	(0.093)	(0.081)	(0.105)	(0.106)
Δln(wage)$_{t-1}$	0.261**	0.262***	0.225***	0.132	0.215**	0.219**
	(0.107)	(0.101)	(0.086)	(0.090)	(0.105)	(0.104)
Δln(real output)$_t$				0.518***		
				(0.053)		
Δln(real output)$_{t-1}$				0.038		
				(0.058)		
Δln(price)$_t$	-0.002	-0.049	0.017		-0.032	
	(0.132)	(0.142)	(0.096)		(0.058)	
Δln(price)$_{t-1}$	0.246**	0.256**	0.179**		0.072	
	(0.112)	(0.102)	(0.072)		(0.061)	
Δ(htech)$_t$	-0.002	-0.001	-0.001	0.001	-0.001	-0.001
(*ex post rental prices*)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)	(0.003)
Δ(htech)$_{t-1}$	-0.003	-0.002	-0.002	-0.001	-0.000	-0.001
(*ex post rental prices*)	(0.003)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Δ(impshare)$_t$	-0.002	-0.001	-0.002*	0.001	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Δ(impshare)$_{t-1}$	-0.001	-0.002*	-0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Joint significance tests						
Δoss$_t$+Δoss$_{t-1}$ =0	$X^2(1)=0.00$	$\chi^2(1)=0.09$	$\chi^2(1)=0.03$	$\chi^2(1)=2.73$	$\chi^2(1)=0.14$	$\chi^2(1)=0.20$
	p-value=0.98	*p-value*=0.76	*p-value*=0.86	*p-value*=0.10	*p-value*=0.71	*p-value*=0.65
Δosm$_t$+Δosm$_{t-1}$=0	$X^2(1)=0.76$	$\chi^2(1)=0.24$	$\chi^2(1)=0.53$	$\chi^2(1)=2.76$	$\chi^2(1)=10.05$	$\chi^2(1)=10.70$
	p-value=0.38	*p-value*=0.62	*p-value*=0.47	*p-value*=0.10	*p-value*=0.00	*p-value*=0.00
Δ(htech)$_t$+Δ(htech)$_{t-1}$=0	$\chi^2(1)=0.62$	$\chi^2(1)=0.16$	$\chi^2(1)=0.58$	$\chi^2(1)=0.00$	$\chi^2(1)=0.04$	$\chi^2(1)=0.07$
(*ex post rental prices*)	*p-value*=0.43	*p-value*=0.69	*p-value*=0.45	*p-value*=0.97	*p-value*=0.84	*p-value*=0.79
Δ(impshare)$_t$ +	$\chi^2(1)=7.00$	$\chi^2(1)=5.14$	$\chi^2(1)=7.50$	$\chi^2(1)=1.98$	$\chi^2(1)=1.75$	$\chi^2(1)=1.78$
Δ(impshare)$_{t-1}$=0	*p-value*=0.01	*p-value*=0.02	*p-value*=0.01	*p-value*=0.16	*p-value*=0.19	*p-value*=0.18
		Shea Partial R^2			Sargan test	
Δoss$_t$	0.136	0.132	0.150	$\chi^2(20)=32.39$	$\chi^2(20)=35.21$	$\chi^2(20)=34.22$
Δoss$_{t-1}$	0.061	0.058	0.121	*p-value*=0.04	*p-value*=0.02	*p-value*=0.02
Δosm$_t$	0.012	0.017	0.033			
Δosm$_{t-1}$	0.012	0.024	0.035		H_0 : no 2nd order autocorrelation	
Hansen J statistic	8.17	10.56	12.77	z = -0.38	z = -0.21	z = -0.01
	$\chi^2(3)=0.04$	$\chi^2(8)=0.23$	$\chi^2(8)=0.12$	*p-value*=0.70	*p-value*=0.84	*p-value*=0.99
Observations	633	633	633	535	535	535

Notes: 1) Includes year and industry effects. Instruments used are same as in previous table.
2) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table A4 Employment and Outsourcing: Instrumental Variables
More disaggregated Manufacturing Industries (450 industries- SIC)

Dependent variable : $\Delta \ln(\text{employment})_t$						
	Conditional labor demand			Unconditional labor demand		
	(1)	(2)	(3)	(4)	(5)	(6)
Δoss_t	-0.139	-0.284	-0.119	-0.237	-0.409	-0.217
	(0.229)	(0.196)	(0.224)	(0.303)	(0.258)	(0.300)
Δoss_{t-1}	-0.270	-0.181	-0.209	0.093	0.169	0.168
	(0.218)	(0.182)	(0.203)	(0.271)	(0.236)	(0.251)
Δosm_t	0.001	-0.002	0.002	0.002	-0.003	0.004
	(0.005)	(0.004)	(0.005)	(0.006)	(0.005)	(0.006)
Δosm_{t-1}	-0.008	-0.001	-0.006	-0.010	0.004	-0.005
	(0.007)	(0.006)	(0.006)	(0.009)	(0.007)	(0.007)
$\Delta \ln(\text{wage})_t$	-0.619***	-0.619***	-0.620***	-0.473***	-0.476***	-0.474***
	(0.062)	(0.062)	(0.062)	(0.070)	(0.070)	(0.070)
$\Delta \ln(\text{wage})_{t-1}$	0.033	0.037	0.034	0.077	0.082*	0.079*
	(0.039)	(0.040)	(0.039)	(0.047)	(0.048)	(0.047)
$\Delta \ln(\text{real output})_t$	0.527***	0.527***	0.529***			
	(0.024)	(0.024)	(0.024)			
$\Delta \ln(\text{real output})_{t-1}$	0.048***	0.049***	0.049***			
	(0.016)	(0.016)	(0.015)			
$\Delta \ln(\text{price})_t$				0.106**	0.089*	0.111**
				(0.053)	(0.046)	(0.050)
$\Delta \ln(\text{price})_{t-1}$				0.028	0.126**	0.051
				(0.074)	(0.058)	(0.069)
year fixed effects	yes	yes	yes	yes	yes	yes
industry fixed effects	yes	yes	yes	yes	yes	yes
Instrument variables						
$IT_{c,t}$ interacted with :	service intensity 1992	high/low oss intensity	business & computing service intensity 1992.	service intensity 1992	high/low oss intensity	business & computing service intensity 1992.
Joint significance tests						
$\Delta oss_t + \Delta oss_{t-1} = 0$	$\chi^2(1)=1.37$	$\chi^2(1)=2.46$	$\chi^2(1)=1.01$	$\chi^2(1)=0.11$	$\chi^2(1)=0.40$	$\chi^2(1)=0.01$
	p-value=0.24	*p-value*=0.12	*p-value*=0.31	*p-value*=0.74	*p-value*=0.53	*p-value*=0.90
$\Delta osm_t + \Delta osm_{t-1} = 0$	$\chi^2(1)=0.57$	$\chi^2(1)=0.16$	$\chi^2(1)=0.17$	$\chi^2(1)=0.42$	$\chi^2(1)=0.02$	$\chi^2(1)=0.02$
	p-value=0.45	*p-value*=0.69	*p-value*=0.68	*p-value*=0.52	*p-value*=0.89	*p-value*=0.90
Shea Partial R^2 :						
Δoss_t	0.126	0.116	0.132	0.121	0.115	0.129
Δoss_{t-1}	0.105	0.112	0.120	0.097	0.103	0.117
Δosm_t	0.032	0.038	0.037	0.029	0.035	0.036
Δosm_{t-1}	0.026	0.032	0.030	0.025	0.031	0.032
Hansen J statistic	13.34	19.06	19.44	6.24	11.87	12.67
	$\chi^2(3)=0.00$	$\chi^2(8)=0.01$	$\chi^2(8)=0.01$	$\chi^2(3)=0.10$	$\chi^2(8)=0.16$	$\chi^2(8)=0.12$
Observations	3,142	3,142	3,142	3,142	3,142	3,142

Notes: Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%

Table A5 Employment and Outsourcing: IV and GMM
More disaggregated Manufacturing Industries (450 industries- SIC)

Dependent variable : Δln(employment)$_t$						
		IV			GMM	
	(1)	(2)	(3)	(4)	(5)	(6)
Δln(employment)$_{t-1}$				-0.035	0.003	0.005
				(0.036)	(0.033)	(0.033)
Δoss$_t$	-0.349	-0.469*	-0.327	0.018	0.044	0.019
	(0.298)	(0.259)	(0.290)	(0.135)	(0.188)	(0.188)
Δoss$_{t-1}$	0.173	0.112	0.183	-0.172	0.035	-0.013
	(0.274)	(0.227)	(0.244)	(0.125)	(0.141)	(0.141)
Δosm$_t$	0.004	-0.005	0.004	0.0040**	0.0041*	0.0040*
	(0.007)	(0.005)	(0.006)	(0.0019)	(0.0022)	(0.0022)
Δosm$_{t-1}$	-0.010	0.001	-0.007	0.0015	0.0011	0.0006
	(0.009)	(0.007)	(0.007)	(0.0012)	(0.0011)	(0.0011)
Δln(wage)$_t$	-0.501***	-0.501***	-0.501***	-0.646***	-0.519***	-0.518***
	(0.068)	(0.069)	(0.068)	(0.072)	(0.086)	(0.086)
Δln(wage)$_{t-1}$	0.077	0.080*	0.078	0.026	0.055	0.056
	(0.048)	(0.048)	(0.047)	(0.059)	(0.066)	(0.066)
Δln(real output)$_t$				0.530***		
				(0.034)		
Δln(real output)$_{t-1}$				0.057*		
				(0.032)		
Δln(price)$_t$	0.108**	0.085*	0.109**		0.140***	
	(0.053)	(0.046)	(0.050)		(0.053)	
Δln(price)$_{t-1}$	0.025	0.110*	0.041		0.099	
	(0.074)	(0.058)	(0.069)		(0.089)	
Δ(htech)$_t$	-0.004*	-0.003	-0.004*	-0.001	-0.003	-0.003
(*ex post rental prices*)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)
Δ(htech)$_{t-1}$	-0.006**	-0.005**	-0.006**	-0.004	-0.004	-0.004
(*ex post rental prices*)	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
Δ(impshare)$_t$	-0.001***	-0.001***	-0.001***	0.000**	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Δ(impshare)$_{t-1}$	0.000	0.000	0.000	0.000*	0.000*	0.000*
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Joint significance tests						
Δoss$_t$+Δoss$_{t-1}$ =0	$\chi^2(1)$=0.16	$\chi^2(1)$=0.91	$\chi^2(1)$=0.13	$\chi^2(1)$=0.50	$\chi^2(1)$=0.09	$\chi^2(1)$=0.00
	p-value=0.69	*p-value*=0.34	*p-value*=0.72	*p-value*=0.48	*p-value*=0.77	*p-value*=0.98
Δosm$_t$+Δosm$_{t-1}$=0	$X^2(1)$=0.23	$\chi^2(1)$=0.22	$\chi^2(1)$=0.07	$\chi^2(1)$=3.61	$\chi^2(1)$=3.33	$\chi^2(1)$=2.51
	p-value=0.63	*p-value*=0.64	*p-value*=0.79	*p-value*=0.06	*p-value*=0.07	*p-value*=0.11
Δ(htech)$_t$+Δ(htech)$_{t-1}$=0	$\chi^2(1)$=5.17	$\chi^2(1)$=3.71	$\chi^2(1)$=5.37	$\chi^2(1)$=1.32	$\chi^2(1)$=1.04	$\chi^2(1)$=1.21
(*ex post rental prices*)	*p-value*=0.02	*p-value*=0.05	*p-value*=0.02	*p-value*=0.25	*p-value*=0.31	*p-value*=0.27
Δ(impshare)$_t$ +	$\chi^2(1)$=21.14	$\chi^2(1)$=25.36	$\chi^2(1)$=22.69	$\chi^2(1)$=6.83	$\chi^2(1)$=38.52	$\chi^2(1)$=39.23
Δ(impshare)$_{t-1}$=0	*p-value*=0.00	*p-value*=0.00	*p-value*=0.00	*p-value*=0.01	*p-value*=0.00	*p-value*=0.00
		Shea Partial R^2			Sargan test	
Δoss$_t$	0.126	0.115	0.136	$\chi^2(20)$=30.19	$\chi^2(20)$=36.50	$\chi^2(20)$=34.67
Δoss$_{t-1}$	0.096	0.109	0.122	*p-value*=0.07	*p-value*=0.01	*p-value*=0.02
Δosm$_t$	0.028	0.041	0.037			
Δosm$_{t-1}$	0.023	0.033	0.031		H_0 : no 2nd order autocorrelation	
Hansen J statistic	5.67	11.70	12.43	z = -0.95	z = -0.04	z = 0.01
	$\chi^2(3)$=0.13	$\chi^2(8)$=0.17	$\chi^2(8)$=0.13	*p-value*=0.34	*p-value*=0.97	*p-value*=0.99
Observations	3,046	3,046	3,046	2,605	2,605	2,605

Notes: 1) Robust standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%
2) There are 13 SICs with missing impshare, and several SICs that has missing employment for different years.